

Negotiated Rulemaking Committee Comment Document

This is an **optional** tool created by your facilitator to help NRM committee members review the Superintendent's recommendations for revised Science Standards. Committee members may also use a paper copy of the document.

Key for Comments from the Committee

+ Good to go!

? Suggested modification, point of clarification, minor language (initial and comment)

! Major concern (initial and comment)

Instructions

- Type your initials in the column that represents your expert opinion. (Note: your initials will appear at the top of the column, but associated with the row)
- If you have a question or need clarification on the language of the standard, select the word or words, then go to the tool bar above and select the comment icon. A dialogue box will open allowing you to make a comment. Type your comment and save by **clicking the "comment" button**. Note that you can delete or edit comments at any time.

IEFA AND SCIENCE FOR ALL K-12 Students	+	?	!
Program delivery standards for Science will ensure integration of the history, contemporary portrayals, and contributions of American Indians, with an emphasis on Montana Indians, for all students, across all content areas. Students will understand that indigenous knowledge is interdisciplinary and is a valid way to interpret and learn scientific concepts. (REF MCA 20-1-501 . Recognition of American Indian cultural heritage -- legislative intent, ARM 10.55.602)			

SCIENCE CONTENT STANDARDS	+	?	!
<p>(1) The content areas included in the Science Standards are</p> <ul style="list-style-type: none"> (a) Physical Science (b) Life Science (c) Earth and Space Science <p>(2) Students will use crosscutting concepts and science and engineering practices while integrating technology to plan, design, conduct, model, evaluate, communicate results, and form evidence-based claims and solutions</p>			

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Physical Science	+	?	!
In physical science, students will investigate how matter and energy exist in a variety of forms and how physical interactions change energy. Students will use crosscutting concepts and science and engineering practices while integrating technology to plan, design, conduct, model, evaluate, communicate results, and form evidence-based claims and solutions.			
Kindergarten			
Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object			
Analyze data to determine whether a design solution works as intended to change the speed or direction of an object with a push or a pull			
Construct explanations based on observations to determine the effect of sunlight on Earth's surface			
Use tools and materials to design and build a structure to reduce the warming effect of sunlight on an area			
First grade			
Plan and conduct investigations to provide evidence that vibrating materials can make sound and that sound can cause materials to vibrate			
Make observations to construct an evidence-based claim that objects can be seen only when illuminated			
Plan and conduct an investigation to determine the effect of placing objects made with different materials in the path of a beam of light			
Design and build a solution that solves the problem of communication over distance using light and sound			
Second grade			
Plan and conduct an investigation to describe and classify various materials by their observable properties			
Conduct an investigation and analyze data to determine which materials have the properties best suited for an intended purpose			
Make observations to construct an evidence-based claim of how an object made of a small set of pieces can be disassembled and made into a new object			
Construct a viable argument using evidence that changes caused by heating or cooling have varying abilities to be reversed			

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Physical Science	+	?	!
Third grade			
Plan and conduct an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object			
Observe and record qualitative and quantitative data about an object's motion to provide evidence that a pattern can be used to predict future motion			
Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other			
Define a simple design problem that can be solved by applying scientific ideas about magnets			
Fourth grade			
Use evidence to construct a claim relating the speed of an object to the energy of that object			
Observe and record qualitative and quantitative evidence of transfer of energy from place to place by sound, light, heat, and electric currents			
Ask questions and predict outcomes about the changes in energy that occur when objects collide			
Apply scientific ideas to design, test, and refine a device that converts energy from one form to another			
Develop a model of waves to describe patterns of amplitude and wavelength which cause objects to move			
Develop a model communicating that light reflected from objects into the eye allows objects to be seen			
Generate and compare multiple solutions that use patterns to transfer information			
Fifth grade			
Develop a model to communicate that matter is made of particles too small to be seen			
Measure and graph ratios and proportions of matter to provide evidence that the total mass of matter is conserved regardless of the type of change that occurs when heating, cooling, or mixing substances			
Observe and record qualitative and quantitative evidence to identify materials based on their properties			

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Physical Science	+	?	!
Conduct an investigation that produces quantitative and qualitative data to analyze whether the mixing of two or more substances results in new substances			
Develop and critique models that communicate flow of energy from the sun to animals through food for body repair, growth, motion, and to maintain body warmth			
Support an argument that the gravitational force exerted by Earth on objects is directed toward the center of the Earth			
6 th – 8 th grades			
Develop and critique models that describe the atomic composition of simple molecules and extended structures			
Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred			
Gather information from multiple sources to describe that synthetic materials come from natural resources and impact society			
Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed			
Develop, use, and critique a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved			
Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes			
Design a solution to a problem involving the motion of two colliding objects that illustrates Newton's Third Law of Motion			
Plan an investigation to provide multiple sources of data as evidence that the mass of the object and the sum of the forces acting on the object affect the object's motion			
Ask questions about data to determine the factors affecting electric and magnetic force strengths			
Construct and present arguments using evidence from multiple sources to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects			

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Physical Science	+	?	!
Design and conduct an investigation to provide evidence that fields exist between objects even though the objects are not in contact			
Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object			
Develop and critique models to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system			
Apply scientific principles to design, construct, and test a device that minimizes or maximizes thermal energy transfer			
Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample			
Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object			
Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave			
Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials			
9 th – 12 th grades			
Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms			
Plan and conduct investigations to gather evidence to compare structure of substances at bulk scales to extrapolate strength between particles			
Develop models to relate changes in atomic nuclear composition to energy released by radioactive decay, nuclear fission and fusion			
Communicate through scientific and technical information roles of molecular-level structure in functioning of designed materials			
Construct and revise explanations for outcomes of simple chemical reactions based on outer electron states of atoms, trends in the periodic table, and patterns of chemical properties			

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Physical Science	+	?	!
Develop a model to illustrate that the release or absorption of energy from chemical reactions are dependent upon changes in total bond energy			
Apply scientific principles and evidence to provide explanations about the effects of changing temperature or concentrations of reactants on reaction rates			
Refine the design of a chemical system by specifying changes in conditions that would alter amount of products at equilibrium			
Use mathematical representations to support claims that atoms and mass are conserved during chemical reactions			
Analyze data to show how Newton's Second Law of Motion describes mathematical relationships between net force, mass, and acceleration			
Use mathematical representations to demonstrate how total momentum of a system is conserved when there is no net force on a system			
Apply scientific and engineering ideas to design, evaluate, and refine devices that minimize forces on an object during collisions			
Use a mathematical representation of Newton's Law of Gravitation and Coulomb's Law to explain gravitational and electrostatic forces between objects			
Plan and conduct investigations to provide evidence that electric currents can produce magnetic fields and changing magnetic fields can produce electric currents			
Create computational models to demonstrate how energy changes in one component of a system when the energy changes of other system components are known			
Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles and energy associated with the relative position of particles			
Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy			
Plan and conduct investigations to show that transfer of energy between two or more components in a closed system results in a uniform energy distribution in that system			

Physical Science	+	?	!
Develop and use models of interacting objects through electric or magnetic fields to illustrate forces between objects and changes in objects' energy due to these interactions			
Use mathematical representations to support claims regarding relationships among frequency, wavelength, and wave speed			
Evaluate evidence, logic, and supporting ideas that electromagnetic radiation may be described as either a wave model, particle model, or both, and for some situations one model is more appropriate than the other			
Develop and use a model to demonstrate potential effects of electromagnetic radiation on matter			
Communicate technical information about how some technological devices use the principles of wave behavior and wave interactions with matter to transmit and capture information and energy			

Life Science	+	?	!
In life science, students will investigate the characteristics, structures, and functions of living things, the processes and diversity of life, and how living organisms interact with each other and their environment. Students will use crosscutting concepts and science and engineering practices while integrating technology to plan, design, conduct, model, evaluate, communicate results, and form evidence-based claims and solutions.			
Kindergarten			
Record observations to describe patterns of what plants and animals, including humans, need to survive			
First grade			
Use materials to design a solution to a human problem by mimicking plant and animal structures and functions which help them survive, grow, and meet their needs			
Use information from print and other media to identify patterns in behavior of parents and offspring that help offspring survive			
Make observations to construct an evidence-based claim that young plants and animals are like, but not exactly like, their parents			
Second grade			
Plan and conduct a cause and effect investigation to determine whether plants need sunlight and water to grow			
Develop a simple model that mimics the structure and function of an animal in dispersing seeds or pollinating plants			
Make observations of plants and animals to compare and contrast the diversity of life in different habitats			
Third grade			
Construct an argument with evidence from multiple sources that in a particular habitat some organisms can survive well, some survive less well, and some cannot survive at all			
Make a claim about the effectiveness of a solution to a problem caused when the environment changes and the types of plants and animals that live there may change			
Construct a cause and effect argument from multiple sources communicating some animals, including humans, form groups and communities that help members survive			
Analyze and interpret data from multiple fossil records to provide qualitative and quantitative explanations of the organisms and the environments in which they lived long ago			
Develop models to evaluate organisms which have unique and diverse life cycles but all have in common birth, growth, reproduction, and death			
Analyze and interpret data from multiple sources to provide evidence that plants and animals have traits inherited from parents and that variation of these traits exists in a group of similar organisms			

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Life Science	+	?	!
Use evidence from multiple sources to support the explanation that traits can be influenced by the environment			
Use evidence from multiple sources to make a claim evaluating the variations in characteristics among individuals of the same species which may provide advantages in surviving, finding mates, and reproducing			
Fourth grade			
Construct a viable argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction			
Use a model to describe that animals receive different types of information through their senses, process the information in their brain, and respond to the information in different ways			
Fifth grade			
Support a viable argument that plants get the materials they need for growth primarily from air and water			
Develop and critique a model to evaluate the movement of matter among plants, animals, decomposers, and the environment			
6 th – 8 th grades			
Conduct an investigation to provide evidence from multiple resources that living things are made of cells; either one cell or many different numbers and types of cells			
Develop and use a model to describe the structure and function of a cell as a whole and ways parts of cells contribute to the function			
Use argument supported by evidence from multiple sources for how the body is a system of interacting subsystems composed of groups of cells			
Construct a scientific explanation based on evidence from multiple sources for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms			
Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and release energy as this matter moves through an organism			
Analyze and interpret data to provide evidence showing the cause and effect relationships of resources on organisms and populations in an ecosystem			
Analyze scientific concepts used by American Indians to maintain healthy relationships with environmental resources			
Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem			
Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems			
Evaluate competing design solutions for maintaining biodiversity and ecosystem services			

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Life Science	+	?	!
Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively			
Construct a scientific explanation based on evidence from multiple sources for how environmental and genetic factors influence the growth of organisms			
Develop and use a model to describe why structural changes to genes located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism			
Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation			
Gather and synthesize information about the technologies that have changed the way humans influence the inheritance of desired traits in organisms			
Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past			
Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationship			
Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy			
Construct an explanation based on evidence from multiple sources that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment			
Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time			
9 th – 12 th grades			
Construct an explanation based on evidence from multiple sources for how the structure of DNA determines the structure of proteins which carry out the essential functions of life through systems of specialized cells			
Develop and use a model to illustrate the organizational structure of interacting systems that provide specific functions within multicellular organisms			
Plan and conduct an investigation to provide evidence that feedback mechanisms promote through positive feedback or inhibit through negative feedback activities within an organism to maintain homeostasis			
Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy			

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Life Science	+	?	!
Construct an explanation based on evidence from multiple sources for how carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur may combine with other elements to form organic macromolecules with different structures and functions, which are the basis of life			
Use a model to illustrate that cellular respiration is a chemical process whereby the bonds of food molecules and oxygen molecules are broken and the bonds in new compounds are formed resulting in a net transfer of energy			
Construct and revise an explanation based on evidence from multiple sources for the cycling of matter and flow of energy in aerobic and anaerobic conditions through an ecosystem			
Use a mathematical model to describe the cycling of energy and matter from one trophic level to another through an ecosystem			
Use mathematical or computational representations to support arguments that biotic and abiotic factors affect carrying capacity, biodiversity, and populations in ecosystems			
Evaluate the claims, evidence, and reasoning that the complex interactions in ecosystems maintain relatively consistent numbers and types of organisms in stable conditions, but changing conditions may result in a new ecosystem and design a solution to maintain stability in an ecosystem			
Analyze scientific concepts used by American Indians to maintain healthy relationships with environmental resources			
Design, evaluate, and refine a solution for reducing the direct and indirect impacts of human activities on the environment and biodiversity			
Construct an explanation using evidence from multiple sources to describe the role of cellular division and differentiation in producing and maintaining complex organisms			
Make and defend a claim based on evidence from multiple sources that inheritable genetic variations may result from: (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, or (3) mutations caused by environmental factors			
Apply concepts of statistics and probability to explain the variation and distribution of expressed traits in a population			
Evaluate and communicate scientific information from multiple sources, including primary sources, that common ancestry and biological evolution are supported by multiple lines of empirical evidence			
Analyze how these concepts uniquely impact American Indians			

Life Science	+	?	!
Construct an explanation based on evidence from multiple sources, including primary sources, that the process of evolution by natural selection primarily results from four factors: (1) the potential for a species to increase in number, (2) the heritable genetic variation of individuals in a species due to mutation and sexual reproduction, (3) competition for limited resources, and (4) the proliferation of those organisms that are better able to survive and reproduce in the environment			
Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to experience less selective pressure causing shifts in numerical distribution of traits			
Construct an explanation based on evidence from multiple sources, including primary sources, for how natural selection leads to adaptation of populations			
Evaluate the evidence from multiple sources, including primary sources, supporting claims that changes in environmental conditions may result in: (1) changes in the number of individuals of some species, (2) the emergence of new species over time, and (3) the extinction of other species			
Analyze American Indian perspectives on changes in environmental conditions and their impact			

Earth and Space Science	+	?	!
In Earth and space science, students will investigate the composition, history, and processes that shape Earth, the Solar System, and the universe. Students will use crosscutting concepts and science and engineering practices while integrating technology to plan, design, conduct, model, evaluate, communicate results, and form evidence-based claims and solutions.			
Kindergarten			
Construct a viable argument supported by relevant evidence from at least one source for how plants and animals, including humans, can change the environment to meet their needs			
Use models to represent the cause and effect relationships between the needs of different plants or animals, including humans, and their local environment			
Communicate solutions that will affect the impact of humans on the land, water, air, and other living things in the local environment			
Use and share observations of local weather conditions to describe patterns over time			
Ask questions and obtain information from at least one source about the purpose of weather forecasting to predict, prepare for, and respond to weather			
First grade			
Use observations of the sun, moon, and stars to describe patterns that can be predicted			
Make observations of patterns at different times of year to relate the amount of daylight to the season			
Second grade			
Obtain information from at least two types of sources to provide evidence that Earth changes can occur quickly or slowly			
Construct explanations to compare multiple physical and naturally built designs which impact wind or water's effect on the shape of the land			
Develop models to represent the shapes and kinds of land and bodies of water in an area			
Obtain information from at least two types of sources to communicate where water is found on Earth as solid, liquid, or gas			
Third grade			
Obtain and represent data using tables and graphical displays to describe observed and predicted weather conditions during a particular season			
Obtain and combine information from multiple sources to describe climate patterns in different regions of the world			
Make a claim based on information from a variety of sources about the merit of a design solution that reduces the impacts of a weather-related hazard			

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Earth and Space Science	+	?	!
Fourth grade			
Obtain and combine information from a variety of sources to communicate that energy and fuels are derived from natural resources and their uses affect the environment			
Identify fossils and rock formation patterns in rock layers as evidence to support a claim about changes in a landscape over time			
Make qualitative and quantitative observations to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, and vegetation			
Analyze and interpret data from maps as evidence to make a claim about patterns of Earth's features			
Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans			
Fifth grade			
Develop and critique a system model that demonstrates interactions of the geosphere, biosphere, hydrosphere, and atmosphere			
Graph and explain the proportion and quantities of water and fresh water in various natural and man-made reservoirs to provide evidence about the distribution of water on Earth			
Obtain and combine information from various sources about ways individual communities use science ideas to protect the Earth's resources, environment, and systems			
Describe how traditional American Indian scientific knowledge can also be used to protect the environment			
Use evidence or models to support the claim that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth			
Graph the daily changes in the length, shape, and direction of shadows; lengths of day and night; and the seasonal appearance of select stars to communicate the patterns of the Earth's movement			
Describe unique cultural perspectives of American Indians regarding astronomy			
6th – 8th grades			
Develop and use a model of the Earth-sun-moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons			
Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system			
Analyze and interpret data to determine scale properties of objects in the solar system			
Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history			

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Earth and Space Science	+	?	!
Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales			
Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions			
Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process			
Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity			
Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes			
Collect data to provide evidence for how the motions and complex interactions of air masses results in changes in weather conditions			
Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates			
Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century			
Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects			
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment			
Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems			
Understand historic and contemporary impacts upon indigenous populations			
9th– 12 th grades			
Develop a model based on evidence from multiple sources to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation			
Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe			
Communicate scientific ideas about the way stars, over their life cycle, produce elements			
Use mathematical or computational representations to predict the motion of orbiting objects in the solar system			
Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks			

Earth and Space Science	+	?	!
Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history			
Analyze sources from American Indians that support scientific concepts and understandings regarding the Earth's formation			
Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features			
Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems			
Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection			
Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes			
Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere			
Construct an argument based on evidence from multiple sources about the simultaneous coevolution of Earth's systems and life on Earth			
Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate			
Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems			
Construct an explanation based on evidence from multiple sources for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity			
Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios			
Illustrate relationships among management of natural resources, the sustainability of human populations, and biodiversity			
Explain how some American Indian tribes use traditional knowledge in managing natural resources			
Evaluate or refine a technological solution that reduces impacts of human activities on natural systems			